SCENARIO EXPLORATION AND IMPLEMENTATION FOR A NETWORK-BASED ENTERTAINMENT ROBOT

Designing emotional interactions of an entertainment robot

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Abstract. For developing usable service robots, deeper knowledge about how the robot should cope with many situations is essential. We suggest some behavioral goals for better communication with network based entertainment robots. First, the robot should show diverse behaviors. Second, the diverse behaviors should be coherent with some traits of personality. Finally, the behaviors or responses of the robot should be understandable and appropriate to all situations. After suggesting appropriate behaviors, we apply a scenario evolution framework. We propose a behavior selection method appropriate for many scenarios.

1. Introduction

Recently, many different types of personal service robots have been introduced and developed, so interface technologies between humans and robots have been discussed in numerous papers. Some reports (Reeves and Nass, 1996; Bumby and Dautenhahn, 1999) show that users dealing with artifacts have a tendency to endow human's character to the artifact, and indeed, there have been many attempts to make intimacy interactions between human and robot. Most research, however, has focused on functional performance of each proposed model. Deeper knowledge, about how the robot copes with various situations under its functional limitations, is needed to develop usable systems. This is a problem related to mapping input stimuli into output actions or analysis tasks of the robot.

Compared to applications in the Human-Computer Interaction (HCI) domain, general service robots have fewer interface units. A personal computer, for example, has a keyboard with numerous keys and a mouse. People do not expect robots to have such interfaces. However, because robots interact with environments through time (Fong, 2001), tasks and interactions between humans and robots are more complicated. To make a robot usable and emotionally intimate, finding appropriate robot behaviors in several situations and determining plausible behaviors for current situation is essential.

In this paper, we introduce a trial of scenario-based behavior design for a network-based entertainment robot. The robot used for our research, Porongbot, is designed for young children (2~7 years old) by KT robotics (2007) and presents some emotional behavior and edutainment services. To provide these services, the robot connects with a robot server, and then downloads edutainment content. The robot can wag two ears, turn its head, and move using wheels under its feet. The colors of its ears, head, and feet can change. The robot also makes sounds and has an LCD screen. For perception, the robot uses touch sensors, microphones, three buttons, and an LCD touch screen.

Figure 1. Porongbot, the robot platform used in this research.

2. Making a Robot Intimate

Entertainment robots ought to deliver intimacy to users. In order to achieve intimate behaviors, we need to consider the following issues.

First, the robot should show diverse behaviors. Limited numbers of behaviors make the user regard the robot as only a tool rather than attribute human character to the robot. For example, a computer making mistakes in its answers to the user's intentions would give that user an impression of humanity. Constantly correct responses of a system in general tasks will not impress human-like conducts.

Second, the diverse behaviors should be coherent with some traits of personality. In the example described above, the errors of the computer could give a felling of humanity, but it may also cause the user to feel uncomfortable with the computer. So, the behaviors should be presented predictably. Via continuous interactions, the user can discover rules about robot behavior preferences and adapt to the rules or adjust them. With these processes, the robot and user can form a human-like relationship. Research about robot behavior preferences (called personality) have been conducted (Tapus and Mataric, 2006; Okuno et. al., 2003; Miwa et. al., 2001).

The behaviors or responses of robots should be understandable and appropriate to all situations. A robot's behaviors are interpreted by the user. The patterns therefore need to be based on related metaphors or hints familiar to the user.

3. Scenario Exploration for Robot Behaviors

3.1. SCENARIO EXPLORATION

Several methodologies for developing usable systems are introduced. Especially, many task analysis methods have been presented in the HCI field. Among them, scenario-based design has been used as a powerful design tool which is easily developed, shared, and manipulated by several researchers and practitioners (Go and Carroll, 2004). We extracted robot behaviors by using a framework of concept and scenario evolution presented by Go and Carroll. The overall process of scenario evolution is depicted in Figure 2.

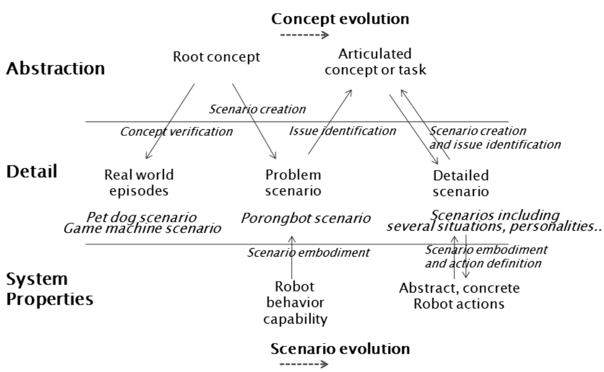

Figure 2. Framework of concept and scenario evolution (Go and Carroll, 2004).

3.1.1. Root Concept

At the beginning of the scenario evolution process, we identified the purposes of the target product and its user. The robot introduced for this research is developed for affectionate entertainment. Its primary users are young children and the purpose of this robot is to form an affective relationship with these primary users. Parents of the children are the secondary users. The parents want the robot to respond emotionally and educationally to their children.

3.1.2. Real World Scenario

Based on the root concept, we described an object's application process or behaviors with concepts analogous to the root concept which is available in the real world. We considered young children's tasks and activities: playing with toys, interacting with parents or friends, using educational contents, watching television, playing video games, sleeping, eating, and so on. We wrote a pet dog scenario and machine video game scenario which are both coherent with the root concept and the tasks.

Pet dog scenario: John is 6 years old. He lives with his parents and two elder sisters. In the afternoon, he comes back from kindergarten and then calls for his puppy. The puppy is barking and waiting for John already. John holds it in his arms and presses his cheek against its cheek. The puppy shows its pleasure by wagging its tail. John turns on a television. At that time, his favorite program starts. Sitting on his knee, the puppy walks around him then calls the boy by wagging its tail. John ignores his pet. Then the dog comes back to John and tries to attract the boy's attention. If he does not respond, the puppy is discouraged. It squats down on a sofa, and then falls asleep.

Video game scenario: After class dismissal, John comes back home. He takes out an electronic game machine and chooses one title, "Go, mountains, and plains." The game shows a green colored screen and plays lilting music. And then it presents a nice and well-organized menu. John selects "new game start" by pressing a start button. After the game explains its contents, John presses several objects on the screen to play. About 30 minutes later, the boy notices that it is time to meet his friend. He clicks on the game's end button. The machine displays a farewell word and then closes itself.

3.1.3. Problem Scenario

A problem scenario was composed by referring to the root concept and the real world episode. This scenario involved Porongbot, so it reflected perceptual and motive functions. The composed scenario is as follows.

Porongbot scenario: John sits on the floor of his room and operates Porongbot. Porongbot has a cheerful and brisk personality which it expresses by emanating bright light from its ear and wagging its body. The robot says, "Hello, I'm Porongbot." John touches the robot. The robot shakes its ears with its head down.

John puts Porongbot on his table. As the robot is laid down, it raises its head and gazes at its master. John presses a button to execute the "reading book" program. The robot receives the command and says, "I will read a book for you," with a cute voice and brilliant light. After that, it drops its head down so that the user can easily use the LCD screen on its head. The reading book service starts.

When the service finishes, John leaves Porongbot on a corner of the table and goes to the main living room. When 5 minutes have passed and the robot has not interacted with its user, the robot turns around and says, "John, what are you doing?" Because it cannot get any response from the user, it says "I am sleepy" and turns itself off.

3.1.4. Articulated Concept or Task

From the basic scenarios, we defined principal tasks: turning on, turning off, playing with, leaving alone, and using services (service start, service end). These classes were not completely independent, but they became a good starting point for detailed scenario development.

3.1.5. Detailed Scenario

The detailed scenarios began by classifying the basic scenario segments into five tasks. The detailed scenarios are derived from the basic scenarios by what-if analysis. The what-if analysis includes 5W+1H of the robot's personality characteristics as well as situations the robot encounters. The analysts wrote related questions about the scenario and new scenario as an answer to the questions. The scenarios involve the robot's behaviors and the user's responses from an interactive view between the user and the robot (Spencer and Clarke, 2004). The written scripts take a regular form with an action sequence. Whenever one scenario was written, we defined the robot's actions and used them in the scenario again. Therefore, we kept expression of the script consistent. A sample is as follows.

Task: Turn on Porongbot

Scenario: John sits on floor of his room and operates Porongbot. Porongbot expresses delight by emanating bright light from its ear and wagging its body. The robot introduces itself with, "Hello, I'm Porongbot."

Script: ;Camera:X/ Microphone:X/ Service:Power_on/ Touch:X; (Sound: "Hello, I'm Porongbot."/ Facecolor:default/ Head:default/ Ear:both_fast_over_flip/ Earcolor:both_ear_rainbow_twinkle)

What-if: If the robot is blunt

Scenario: John sits on the floor of his room and operates Porongbot. The blunt robot moves its ear, and says, "Hi."

Script: ;Camera:X/ Microphone:X/ Service:Power_on/ Touch:X; (Sound: "Hi"/ Facecolor:default/ Head:default/ Ear:left_middle_bottom/ Earcolor:default/)

3.2. TRAITS OF BEHAVIOR CATEGORIZATION

Abundant behaviors (over 150) were explored through a process which ranges from root concept to detailed scenario development. These behaviors were expressed with definite available input and output actions. Each behavior can be categorized by how the behavior is agreeable, or how the behavior is social from the user's viewpoint. Via computer simulation, each behavior was evaluated with three parameters: sociability, activity, and agreeableness. Sociability is how easily the robot generates dialogue. Activity is how intensively the robot moves. Agreeableness means how kindly the robot behaves. For keeping objectivity, five evaluators gave positive, negative, and neutral values to each behavior. If a disagreement among the evaluators was found, the resulting value was decided by majority.

4. Script-based Robot Behavior

The developed scenarios were implemented in actual robot operation as forms of scripts. As a result of the previous process, the robot behavior database involves antecedent conditions for each behavior, action sequence, or script, and trait values for the behavior are evaluated by three parameters. For implementation of the database, we established a behavior selection model. Flows of information in the model are shown in Figure 3.

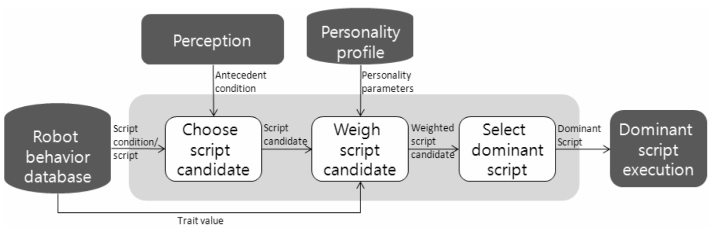

Figure 3. Information flow diagram for the behavior selection model.

First, input stimuli or changed internal state are delivered to the behavior selection model. The selection model searches scripts which fit the current situation from the robot behavior data-base, and then settle on appropriate script candidates. These script candidates are weighted by the robot's personality profile. Personality profile refers to a robot's trait level about sociability, activity, and agreeableness. They range from -1 to 1 and script weights are decided from them and the trait values described in the robot behavior database. Consequently, the more traits similar to the personality profile a script has, the higher weight it gets. One dominant script is selected by a weighted random selection method (related work was conducted by Kim et al., 2007). The dominant script is expressed by using several actuators such as ears, head, and colors.

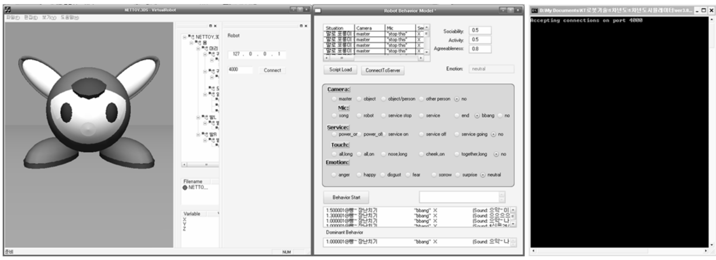

Figure 4. 3D robot simulator, behavior selection simulator, and server

The proposed model was implemented with a 3D robot simulator. The model manages the software robot by using socket communications (Figure 4). The behavior selection simulator has several radio buttons creating situations and fields setting the robot's traits and showing the scenarios. When the behavior selection simulator runs, the model selects one dominant script and sends it to a 3D robot simulator through the server. The 3D simulator behaves according to the script.

5. Conclusion

In this paper, we introduced a method of extracting appropriate and diverse behaviors by a scenario-based analysis. We also proposed a probabilistic behavior selection model which operates many different explored behaviors according to personality parameters. An approach based on script models has some advantages. It allows complex behaviors involving intention understanding and action planning issues based on task analysis using scenarios. This ensures flexible and coherent robot behavior. It can also show the robot's personality. Finally, we can attempt continuous behavioral learning techniques during the behavior selection process. Consequently, we could study the mechanism of behavior reinforcements and semantic interaction.

Acknowledgements

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